

## ROTARY SWITCH WITH RATCHETING FEATURE

### TECHNICAL FIELD

This invention relates in general to electronic devices, and more particularly to  
5 rotary switches used in electronic devices.

### BACKGROUND

A rotary switch is often used as means for selecting an electronic device  
parameter. For example, a rotary switch may operate as a channel selector on a public  
10 safety radio to give quick, simple access to a number of channels. The switch typically  
provides a continuous rotary "increment / decrement" function but is limited by the  
number of physical positions on the switch. A separate "zone" switch is sometimes  
used in conjunction with the rotary switch to allow access to separate banks of  
channels, but each bank of channels is still limited by the number of physical positions  
15 on the switch. The ability to provide increased channel selection, or other parameter,  
is highly desirable.

In the case of the public safety radio, there are many users, such as fire fighters  
wearing bulky gloves, who prefer that the rotary switch have a mechanical stop  
feature. The mechanical stop feature allows the switch to be turned fully  
20 counterclockwise to select, for example an emergency channel, and fully clockwise to  
select a default normal operating channel. This operation is easy to do without looking  
at the radio while it is mounted on a belt or harness. However, the mechanical stop  
limits the use of the switch to that one selected channel. The ability to select different

types of parameters, such as channel, zone, and coding scheme, as well as an increased selection within each parameter is also highly desirable.

Accordingly, there is a need for an improved rotary switch for an electronic device, such as a radio, that provides increased parameter selection with good tactile  
5 feedback for the user.

### BRIEF DESCRIPTION OF THE DRAWINGS

The features of the present invention, which are believed to be novel, are set forth with particularity in the appended claims. The invention, together with further  
10 objects and advantages thereof, may best be understood by reference to the following description, taken in conjunction with the accompanying drawings, in the several figures of which like reference numerals identify like elements, and in which:

FIG. 1 is an electronic device formed in accordance with the present invention;

FIG. 2 is a top view of the electronic device of FIG. 1 formed in accordance  
15 with the present invention;

FIG. 3 is the rotary switch of FIG. 1 operating in accordance with the present invention;

FIG. 4 is the rotary switch of FIG. 3 operating in accordance with the present invention; and

20 FIG. 5 is a method of expanding the range of a rotary switch for an electronic device in accordance with an alternative embodiment of the invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

While the specification concludes with claims defining the features of the invention that are regarded as novel, it is believed that the invention will be better  
5 understood from a consideration of the following description in conjunction with the drawing figures, in which like reference numerals are carried forward.

In accordance with the present invention, there is provided herein a rotary switch having a ratcheting feature for facilitating scrolling through a plurality of device parameters. FIGs. 1 and 2 are front and top views of an electronic device 100,  
10 shown here as a radio communication device. In accordance with the present invention communication device 100 includes a rotary switch 102 for scrolling through a scrollable parameter, a bump stop 104 for inhibiting rotation of the rotary switch and triggering a ratcheting function for the rotary switch, and preferably an input 106 for enabling and disabling a plurality of scrollable parameters. Scrollable  
15 operating parameters for the communication device 100 can be selected from, but are not limited to, channel, zone, and coding schemes.

Rotary switch 102 is capable of rotating in a first direction and a second (reverse) direction. In accordance with the present invention, the rotary switch 102 hitting the bump stop 104 in the first direction enables ratcheting in a second direction  
20 and incrementing a device parameter in the first direction. The rotary switch 102 hitting the bump stop in the second direction enables ratcheting in the first direction and decrementing the device parameter in the second direction. By hitting the bump stop 104 in either direction the user is able to ratchet rapidly up or down the scrollable parameter list. Reversing direction of rotation without hitting the bump stop 104

simply leaves the rotary switch 102 in plain increment / decrement mode. Input 106 allows for the selection of various parameters through which the rotary switch 102 can scroll.

Referring now to FIGs. 3 and 4, a top view of the rotary switch 102 is shown  
5 operating in accordance with a preferred embodiment of the invention through a series of rotations 300, 400 labeled (1)-(9). For the purposes of this example, rotation in the first direction will be considered to be in the clockwise direction and rotation in the second direction will be considered to be in the counterclockwise direction. The rotary switch 102 initially increments and decrements through a first scrollable  
10 parameter, a default parameter, regardless of hitting the bump stop. Input 106 is then enabled thereby disabling the first scrollable parameter and enabling a second scrollable parameter. Rotation of the rotary switch 102 in the clockwise direction 302 now increments the second parameter. Continued clockwise rotation 304, stopping prior to hitting the bump stop 104, continues to increment the second parameter, and  
15 rotation in the counterclockwise direction 306 decrements the second parameter (i.e. regular increment/decrement functionality).

The rotary switch 102 continues to increment and decrement the second scrollable parameter with clockwise and counterclockwise rotations until the bump stop 104 is hit with full clockwise rotation 308, view (4). In accordance with the  
20 present invention, in response to the bump stop 104 being hit in the clockwise direction 308, the ratcheting feature is enabled in the counterclockwise direction 310 and incrementing of the second scrollable parameter is enabled in the clockwise direction 312. Thus, once the ratcheting feature is triggered in the clockwise direction, turning the rotary switch 102 in the counterclockwise direction has no effect on the

second parameter. The action of rotate clockwise (hit bump stop), reverse rotate counterclockwise (do not hit bump stop), and rotate clockwise (hit bump stop) continues the increment/ratchet/increment feature of the present invention. If the user pauses midway through a clockwise rotation (without hitting bump stop) as seen back  
5 in view (2) designator 304 and then reverses rotation as seen in view (3) designator 306, the second parameter will decrement. Thus, the user can easily scroll to the desired parameter.

In response to the bump stop 104 being hit in the counterclockwise direction 314 view (7), the ratcheting function is enabled in the clockwise direction 316 and  
10 decrementing of the second scrollable parameter occurs in the counterclockwise direction 318. Thus, once the ratcheting function is triggered in the counterclockwise direction, turning the rotary switch in the clockwise direction has no effect on the second parameter. The action of rotate counterclockwise (hit bump stop), reverse rotate clockwise (do not hit bump stop), and rotate counterclockwise (hit bump stop)  
15 continues the decrement/ratchet/decrement feature of the present invention. If the user pauses midway through a counterclockwise rotation (without hitting bump stop) and then reverses rotation, the second parameter will increment. Thus, the user can easily scroll to the desired parameter.

As an example, input 106 can disable a channel change parameter that scrolls  
20 up and down through sixteen channels (first parameter) and enables a PL code parameter having say fifty PL codes (second parameter). If the bump stop 104 is located in between positions one and sixteen then switch 102 will initially scroll up and down through sixteen of the fifty PL codes. To scroll to higher level PL codes, the user rotates the switch all the way in the clockwise direction until the bump stop

104 is hit. By hitting the bump stop 104 in the clockwise direction, the ratcheting feature is triggered. Rotation in the opposite (counterclockwise) direction will no longer impact the PL code, but subsequent clockwise rotation will increment the PL code. The user continues to repeat the clockwise rotation (hitting bump stop), reverse rotation counterclockwise (without hitting bump stop), and rotate clockwise (hitting the bump stop) until the desired PL code is reached or nearly reached. To further facilitate reaching the desired parameter, the user may pause midway through a clockwise rotation (without hitting bump stop) and then reverse rotate the switch so as to decrement the parameter.

10           Now to decrement the PL code, the user rotates switch 102 counterclockwise until the bump stop 104 is hit which triggers the ratcheting feature to be enabled in the opposite (clockwise) direction. The user continues to repeat the counterclockwise rotate (hit bump stop), reverse rotate in clockwise direction (without hitting bump stop), and counterclockwise rotate (hitting bump stop) until PL code is decremented to  
15 the desired level. To assist the user in reaching the desired parameter, the user may pause midway through a counterclockwise rotation (without hitting bump stop) and then reverse rotate the rotary switch so as to increment the parameter.

          The rotary switch of the present invention can be configured with a number of bump stops and different bump stop locations if desired. For example, as an  
20 alternative to having one bump stop located between the first and last positions of the rotary switch 102 as described above, two bump stops can be used that are located at the first and last switch positions. In the case of a sixteen channel switch, once the bump stop is hit (at position one or sixteen) the user is left with fourteen usable switch positions through which to scroll and ratchet. Thus, a communication device that has

a default function such as “emergency” located at channel 16 can maintain channels one through fifteen and emergency until input 106 is enabled. Once input 106 is enabled, a second scrollable parameter is turned on and channels 1 and 16 function as bump stops.

5           The input 106 can be used to enable other parameters as well. Thus, the same rotary switch can be used to accommodate many different electronic device parameters each parameter having different scrollable levels. The physical limitations of the switch are no longer a factor in determining the number of available scrollable parameters. The user can now easily scroll through a number of different parameter  
10 types and different levels/positions within each type through a single rotary switch.

          While shown and described in the preferred embodiment as using an input 106 to select one of a plurality of device type parameters, the ratcheting feature of the present invention is also useful for applications utilizing a single type of device parameter. If design requirements are such that one parameter type is sufficient, then  
15 input 106 is no longer needed. The ratcheting feature still provides an increased number of positions from which to select within that one parameter. For example, a radio communication device having rotary switch 102 operating as a channel selector having sixteen channels can increase the number of available channels by simply hitting the bump stop to enable the ratcheting feature as described above. The user can  
20 then scroll up and down the channels as desired.

          Another alternative embodiment allows incrementing of the scrollable parameter to occur in both clockwise and counter clockwise directions of the rotary switch. In this case, the user rotates the switch 102 clockwise to increment the parameter and hits the bump stop 104 so that counterclockwise rotation continues to

increment the parameter. Subsequent clockwise rotation (hitting the bump stop) and counterclockwise rotation continues to increment the parameter. If the bump stop is not hit each time in the clockwise direction, then counterclockwise rotation

decrements the parameter. In other words, the action of hitting of the bump stop

5 triggers the ability to increment or decrement in the counterclockwise direction. Thus, the use of the bump stop in accordance with the present invention, triggers the ability to increment and decrement the plurality of scrollable parameters of a rotary switch.

Accordingly, there has been provided a rotary switch for an electronic device that includes a bump stop for inhibiting rotation of the rotary switch, the bump stop

10 triggering a ratcheting feature that inhibits scrolling through an electronic device parameter in one rotation direction and enables scrolling through the electronic device parameter in the opposite rotation direction. Depending on which direction the bump stop gets hit, scrolling may increment the electronic device parameter or decrement the electronic device parameter.

15 Electronic devices such as public safety radios, cell phones, set top boxes, and other equipment using rotary switch interfaces can all benefit from the ratcheting feature of the present invention. A single rotary switch having a fixed number of positions can now provide additional scrolling capability to one or more types of parameters through the ratcheting feature of the present invention. The use of the  
20 bump stop to trigger the ratcheting feature provides good tactile feedback for the user.

In accordance with another embodiment of the invention, there is further provided herein a method for expanding the range of a rotary switch for an electronic device. For the purposes of this application, the rotary switch is characterized by a predetermined number of positions. Here again, the press of a button or menu



selection on the electronic device, such as button 106 on radio communication device 100 of FIG. 1, changes the device parameter from a default parameter to some other user selected parameter. Referring to the flowchart 500 of FIG. 5, the entire range of the enabled parameter is spread across the range of movement of the rotary switch at 502 which determines a coarse step size at 504. For example, if the entire range of the enabled parameter is 0 - 1000, then this range is spread across the range of movement of the rotary switch (say 1 - 16) giving a coarse step size of  $1001 / 15 = 66.7$ . Turning the rotary switch clockwise increments the parameter with the coarse step size towards a desired parameter value at 506.

10           In accordance with this embodiment, the user overshoots the desired parameter value by one position 508 (i.e. one coarse step). Turning the rotary switch counterclockwise 510 now updates the coarse step size and decrements the device parameter with the updated coarse step size. The updated coarse step size is determined via steps 512 and 514. Upon reversing the rotation of the rotary switch  
15           direction at 510, the number of usable switch positions is determined at 512 and this number of usable switch positions is used to determine the updated coarse step size, 514. For the purposes of this application, the number of usable switch positions is determined by the distance from current switch position to the bump stop 104 in the desired direction of rotation. In accordance with this embodiment, the updated coarse  
20           step size is determined at 514 using: absolute value of (current parameter value - previous parameter value) / number of usable switch positions.

The user continues to turn the rotary switch counterclockwise until the user overshoots the desired parameter value by one position, 516. Turning the rotary switch clockwise now updates the coarse step size and increments the parameter. As

before, updating of the coarse step size is based on the current parameter value, the previous parameter value, and the number of usable positions. The user continues clockwise and counterclockwise rotations, zeroing in on the desired parameter value until the step size reaches one or less.

- 5 Continuing with the example, an initial coarse step size of 66.7 was determined for a rotary switch having sixteen positions and a parameter range 0-1000. For a desired value of 669, starting at 0 (switch position 1 of 16), the number of rotary positions and parameter values turning clockwise (step 506) are as follows (rounding off):

- |    |  |
|----|--|
| 10 | position 1, parameter =67,                               |
|    | position 2, parameter =133,                              |
|    | position 3, parameter =200,                              |
|    | position 4, parameter =267,                              |
|    | position 5, parameter =333,                              |
| 15 | position 6, parameter =400,                              |
|    | position 7, parameter =467,                              |
|    | position 8, parameter =533,                              |
|    | position 9, parameter =600,                              |
|    | position 10, parameter =667,                             |
| 20 | position 11, parameter =733, (overshoot by one position) |

Now turning the rotary switch counterclockwise (steps 510, 512, 514) the following occurs:

- The number of usable switch positions is now 11 (distance from current switch position to bump stop in direction of rotation).

The updated coarse step size is thus  $\lceil (\text{current parameter value} - \text{previous parameter value}) / \text{number of usable switch positions} \rceil = \lceil 733 - 667 \rceil / 11 = 6$

Using the updated coarse step size of 6 in the counterclockwise direction provides the following:

5            position 12, parameter =727,  
              position 13, parameter =721,  
              position 14, parameter =715,  
              position 15, parameter =709,  
              position 16, parameter =703,  
              position 17, parameter =697,  
 10           position 18, parameter =691,  
              position 19, parameter =685,  
              position 20, parameter =679,  
              position 21, parameter =673,  
              position 22, parameter =667, (overshoot by one position)

15

Now turning the rotary switch clockwise (step 518) enables the following:

The number of usable switch positions is 16 (distance from current switch position to bump stop in direction of rotation).

20           The updated coarse step size =  $\frac{|(\text{current parameter value} - \text{previous parameter value})|}{\text{number of usable switch positions}}$

The updated coarse step size is now  $|667-673|/16 < 1$ , so use updated coarse step size of 1.

             position 23, parameter =668,  
 25           position 24, parameter =669

Thus, in 24 rotary position transitions (like one and a half full rotations of the 1-16 rotary switch), and two switch direction transitions, the desired parameter value of 669 out of 1001 possible values has been achieved.

30           The method of expanding the rotary switch range allows a switch with a limited number of physical positions to be used for other operating parameters having wider

ranges than the default parameter. The switch action is quite natural for the user to learn in that the user just continues to rotate the switch back and forth zeroing in on the desired parameter value. The range of the rotary switch is capable of being reset to the initial coarse step size via a user input, such as hitting the bump stop twice in  
5 quick succession or other interface means.

The method described above can be varied in a number of ways depending on the design requirements of the electronic device. For some designs it may be desirable to change the direction of rotation to increment in the counterclockwise direction and decrement in the clockwise direction. Design conditions may warrant  
10 using an overshoot of  $N > 1$  positions rather than a single position. While using more than one position will require more switch transitions to narrow the range, this may provide improved user interface as the user realizes they have overshoot the desired parameter and need to change rotation direction. Undershooting the desired parameter value by one or more positions can also be used instead of overshooting in order to  
15 alter the step size and adjust the parameter. For an undershooting implementation, the adjustment to the coarse step size would preferably be slightly larger than one. Thus, the method of expanding the range allows the user to continue rotating the rotary switch in both directions to alter the coarse step size and adjust the parameter until the desired parameter value is achieved.

20 Accordingly, there has been provided a means of providing additional scrolling capability to a rotary switch having a fixed number of positions through the use of the ratcheting and bump stop feature of the present invention. There has further been provided a method for expanding the range of the rotary switch by modifying the step size of the switch based on the range of a selected parameter and then narrowing

the step size with each change in rotation based on current, previous and useable switch positions.

While the preferred embodiments of the invention have been illustrated and described, it will be clear that the invention is not so limited. Numerous  
5 modifications, changes, variations, substitutions and equivalents will occur to those skilled in the art without departing from the spirit and scope of the present invention as defined by the appended claims.

What is claimed is: